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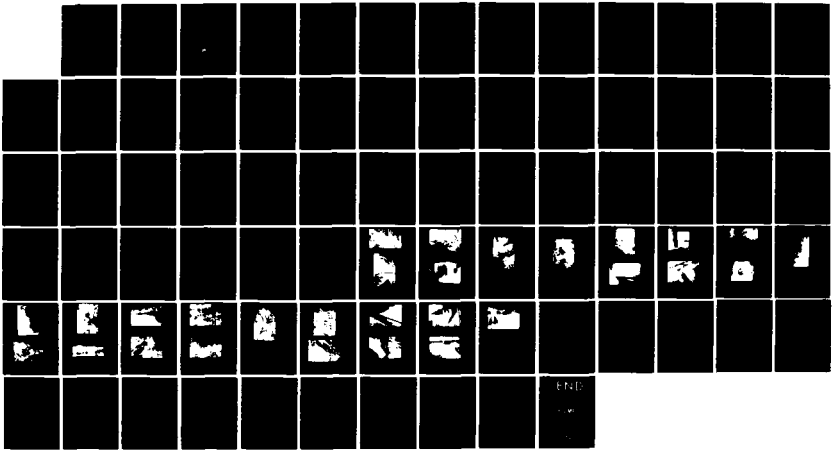

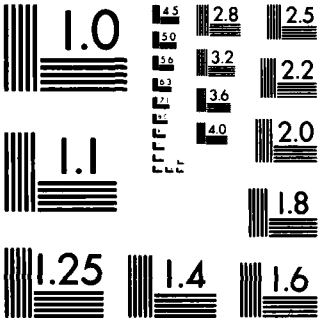

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WOONASQUATUCKET, RIVER BASIN

SMITHFIELD, RHODE ISLAND

WATERMAN RESERVOIR DAM

R.I. 03103

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

AUGUST 1978

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Woonasquatucket River Basin
Smithfield Rhode Island
Stillwater River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is in good to fair condition,having stood for more than 140 yrs. The only visible signs of distress are the sloughed areas on the upstream slope of the dam near the gate house and cavitation of the walls of the discharge conduit. The dam has a significant hazard potential. It is recommended that the owner solicit the services of a qualified consultant to make a detailed hydrological and hydraulic investigation of the entire drainage area.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

Honorable J. Joseph Garrahy
Governor of the State of Rhode Island
and Providence Plantations
State House
Providence, Rhode Island 02903

Dear Governor Garrahy:

I am forwarding to you a copy of the Waterman Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Management, the cooperating agency for the State of Rhode Island. In addition, a copy of the report has also been furnished the owner, Woonasquatucket Reservoir Company, Greystone Road, North Providence, Rhode Island 02911.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Management for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHAMBERLAIN
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

WATERMAN RESERVOIR DAM

RI 03103

WOONASQUATUCKET RIVER BASIN
SMITHFIELD, RHODE ISLAND

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION REPORT

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	-	Waterman Reservoir Dam
State	-	Rhode Island
County	-	Providence
Stream	-	Stillwater River
Date	-	15 and 21 December 1977

The dam is in good to fair condition, having stood for more than 140 years. The only visible signs of distress are the sloughed areas on the upstream slope of the dam near the gate house and cavitation of the walls of the discharge conduit. Hydraulic analyses indicate that the spillway will be overtopped during the occurrence of the Probable Maximum Flood (PMF). Additionally, in the event of a dam failure, a significant to high hazard exists downstream of the dam. Because of this hazard potential and the lack of available design and construction data, it is recommended that the owner solicit the services of a qualified consultant to make a detailed hydrologic and hydraulic investigation of the entire drainage area.

Frank Notardonato

FRANK NOTARDONATO, P.E.
Rhode Island
Registration Number 2318

This Phase I Inspection Report on Waterman Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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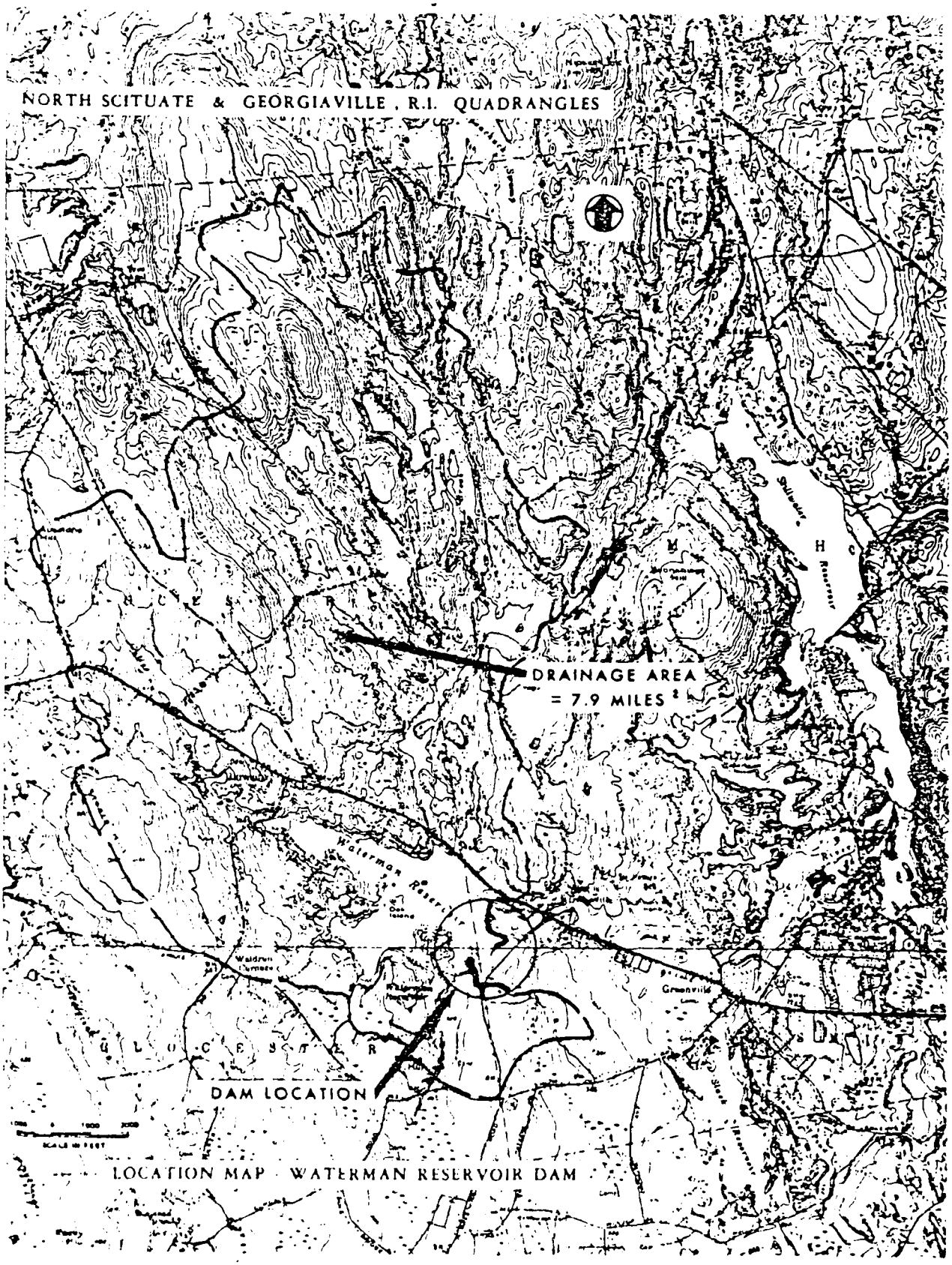


LOCATION MAP - WATERMAN RESERVOIR DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

WATERMAN RESERVOIR

ID# RI 03103

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of the inspection of dams within the New England Region.

b. Purpose.

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam and its appurtenances are located in Providence County on the boundary of the towns of Gloucester and Smithfield, R.I., with the western end of the concrete core dike in Gloucester and the remaining sections in Smithfield. The dam is flanked on the north side by U.S. Route 44 and crossed near the spillway by West Greenville Road. The Waterman Reservoir is situated on the Stillwater River within the Woonasquatucket River Basin. Two smaller dams and one larger reservoir, the Stillwater, are located downstream.

b. Description of Dam and Appurtenances. The Waterman Reservoir Dam is an old, long earthen structure impounding a relatively shallow regulating reservoir used for industrial water supply and recreation. The entire structure consists of a main dam, an earth dike and a spillway structure abutted on each side by concrete core dikes. An overall view of the entire project is shown on Figure 1 - Appendix B. Typical sections are shown in Figure 2. The main dam is approximately 19 feet high at its highest point at the gate house and 550 feet long abutting into high ground at each end. The top elevation is estimated 334'± MSL. The dam is basically an earth section with a dry masonry wall along the upstream slope. (Photograph 1) There is a 4' x 6' concrete conduit running through the dam at its highest point. Flows through the dam are regulated by a manually operated wooden slide gate. Upstream wing walls leading to the gates and trash bars consist of 1.5 foot wide concrete walls. The downstream wing walls are constructed of 1.0 x 2.5 x 4.5 foot granite blocks stacked without mortar.

The earthen dike portion of the facility is 1500 feet long and has a top elevation of 334'± MSL. The 220 foot length closest to the main dam is similar in section as the main dam. The remaining 1280 feet of this dike is a conventional earth dike having a 1.3:1 upstream slope and 1:1 downstream slope.

The concrete core dike is 2380 feet long with 550 feet located east of the spillway and 1830 feet located west of the spillway. The dike is constructed of earth with 1:1.5 side slopes and a top width of 3 feet. The concrete core is 1 foot wide and extends to the top of the dike.

The spillway which has a length of 201 feet is a granite block capped overflow structure with a top elevation of 330'± MSL. There are wing walls at each side of the spillway.

c. Size Classification. The dam is classified in the immediate category.

d. Hazard Classification. The project is classified as significant to high hazard. There is a 10 foot high Route 44 highway embankment across the river about 1500 feet downstream of the dam. Below the highway are between 1 and 2 dozen exposed single family residences, two industrial buildings and a school.

e. Ownership. The dam is owned, operated and maintained by the Woonasquatucket Reservoir Company, Greystone Road, North Providence, R.I.

f. Operator. Operation and inspection of the four Woonasquatucket Reservoir Co. dams; Stump Pond (Stillwater Reservoir), Mountaindale, Waterman and Slacks Pond, is performed as part of the job of the master mechanic of Worcester Textile, the largest water user. The present master mechanic is Mr. Ivar Elfgren who can be contacted through the:

Maintenance Dept.
Worcester Textile
Greystone Ave.
Centerdale, R.I. 02911
TEL. NO. (401)231-4500

g. Purpose of Dam. The main purpose of the dam is to provide additional storage for the Stillwater Reservoir (Stump Pond), which in turn provides water throughout the year to downstream industrial processes. Additionally, the Waterman Reservoir which is impounded by the dam is used for recreational purposes throughout the year.

h. Design and Construction History. Design data, other than that shown in Figures 1 and 2 is not available. The original dam was constructed in 1837. Documented inspections of the dam conducted by state personnel over the years provide the only factual history that is available. These reports are found in Appendix B. In addition, conversations with long time residents of the area revealed that the gate house and outlet works were reconstructed in the mid-1920's. At that time, the 2' x 3' culvert, shown on the typical sections in Figure 1, was modified to 4' x 6'.

i. Normal Operational Procedures. The reservoir is normally maintained filled to spillway crest. Regulated releases from storage to the downstream Stillwater Reservoir are provided through the 1.3 x 1.3 foot opening in the 4 x 6 foot gate. The smaller 2 x 3 foot gate is opened in September of each year and allowed to remain open until March at which time it is closed to allow storage of the spring freshet. A full pond is usually reached in June with subsequent overflows passing over the spillway. The dam is visited weekly by the owner's representative and a report furnished the owners on the gate setting and an estimate of the reservoir level. More frequent visits are made during periods of heavy rainfall. The dam and all appurtenances are inspected yearly by the owner's representative. Significant damages are reported verbally during the staff meeting held after the inspection.

1.3 Pertinent Data

a. Drainage Area. As determined from the U.S.G.S. sheets (North Scituate and Georgiaville, R.I. Quadrangles) the drainage area is 8.0 square miles.

b. Discharge at Damsite. There are no discharge records available for the project. Outflow at the dam occurs over the 201-foot spillway, or through the 1.3 x 1.3 foot opening in a 4 x 6 foot wooden sluice gate in the outlet works. The 4 x 6 foot wooden gate has not been operated in the last 15 years. Mounted to the 4 x 6 foot gate on the upstream side is a 2 x 3 foot wooden gate that is opened in the Fall and closed in the Spring. Even with the 2 x 3 foot gate fully open, the effective control is still the 1.3 foot opening; and, all large flows must pass over the spillway.

A low culverted causeway (opening 12 x 9 foot) is located across the reservoir upstream of the spillway and a culverted (opening 9.5 x 8 foot) Route 44 highway embankment is located downstream of the spillway as shown on the quadrangle map (Figure 3, Appendix B). Approximate composite rating curves were developed at the upstream causeway, the overflow and non-overflow sections of the dam, and the culvert under Route 44. The developed rating curves are inclosed in the Appendix. With the pool at elevation 334 feet MSL (top of dam) the total outflow capacity at the dam is about 4,500 cfs. Maximum capacity of the 1.3 foot outlet opening is approximately 40 cfs. If the 4 x 6 foot gate were open, then the maximum outlet capacity would be increased to about 550 feet cfs. Paragraph b. of Section 5 contains further discharge information.

(1) Outlet Works - 4 ft x 6 ft conduit (invert Elev. 317)

(2) Maximum known flood at damsite - Unknown

(3) Ungated spillway at maximum pool elevation - 4500 cfs at 330 ft. elev. (MSL)

(4) Gated spillway capacity at pool elevation - not applicable

(5) Gated spillway capacity at maximum pool elevation - not applicable

(6) Total spillway capacity at maximum pool elevation - 4500 cfs at 334 ft. elev. (MSL)

c. Elevation (ft. above MSL)

(1)	Top Dam	334±
(2)	Maximum pool-design surcharge	330±
(3)	Full flood control pool	330±
(4)	Recreation pool	330±
(5)	Spillway crest (gated)	330±
(6)	Upstream portal invert diversion tunnel	not applicable
(7)	Streambed at centerline of dam	317±
(8)	Maximum tailwater	not known

d. Reservoir

(1)	Length of maximum pool (at spillway crest)	5800 ft.
(2)	Length of recreation pool	5800 ft.
(3)	Length of flood control pool	5800 ft.

e. Storage (acre-feet)

(1)	Recreation pool	2430±
(2)	Flood Control pool	2430±
(3)	Design surcharge	3750±
(4)	Top of dam	3750±

f. Reservoir Surface (acres)

(1)	Top dam	355±
(2)	Maximum pool	270±
(3)	Flood control pool	270±
(4)	Recreation pool	270±
(5)	Spillway crest	270±

g. Main Dam and Dikes

(1)	Type	Earth
(2)	Length (Main Dam)	550 feet
(3)	Length (Dikes)	3880 feet
(4)	Height (Dam @ Gate Structure)	19 feet
(5)	Top Width	Varies 6 to 10 feet
(6)	Side Slopes	Varies (See Figure 2)
(7)	Zoning	Unknown
(8)	Impervious Core	Unknown
(9)	Cutoff (Core Dike Only)	Concrete
(10)	Grout Curtain	Unknown

h. Spillway

(1)	Type	Fixed crest ungated overflow
(2)	Length of weir	201 feet
(3)	Crest Elevation	330 ft.± above MSL
(4)	Gates	None
(5)	U/S channel	Stone lined
(6)	D/S channel	Natural stream bed
(7)	General	

The spillway is an uncontrolled overflow type and is constructed of granite stones (some of which have dislodged and moved downstream). Vegetation and brush growing on the downstream side have reduced effective low flow capacity. The crest is at elevation 330 feet MSL. The approach channel upstream of the spillway channel is in poor condition and heavy brush and vegetation have reduced the discharge capacity.

SECTION 2

ENGINEERING DATA

2.1 General

Neither engineering nor construction data is available on the Waterman Reservoir Dam; therefore, data evaluation could not be made.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The dam and its appurtenances are in good to fair condition with no major visual problems noted. Minor erosion and vegetation problems have been noted throughout the length of the project. At this time they do not affect the integrity of the structures.

b. Dam. The dam is heavily overgrown with vegetation including many trees having trunk diameters up to 8 inches. Tree and brush growth covers the entire downstream slope and the upstream slope above the grouted riprap. (Photographs 2 and 3) The condition of the upstream slope could only be inspected above the elevation of the water.

In this area the riprap consists of stones varying from 2 to 8 inches in size with some areas void of all stone. Large sloughed areas exist on either side of the gate house. (Photographs 4 thru 7) These have resulted in the riprap being removed exposing the underlying embankment materials which consist of a bony gravel with maximum sizes to 2-inch diameter. The concrete stairs on on the left side of the gate house have dropped approximately 3.5 feet below the top of the gate house foundation because of the sloughing of the slope in this area. (Photographs 7 and 8)

Seepage noted from the masonry wall on the downstream slope, probably had been caused by recent rains, snow melt and ground thaw. Seepage was also noted from the north wing wall of the outlet channel after the gate was closed. (Photograph 9) The seepage appeared to contain sawdust. (Photographs 10 and 11) At the time this seepage was noted, heavy rain was falling.

Erosion and cavitation to depths of 6 to 12 inches has occurred on both sides of the conduit downstream of the slide gate. This

cavitation starts about 10 feet from the gate on a line from the top of the culvert at the gate and extends to the bottom of the culvert approximately 35 feet downstream of the gate. The erosion is approximately 2" wide and in some areas increases to approximately 12". (Photographs 12, 13 and 14)

c. Appurtenant Structures.

(1) Dike. The dike is in good to fair condition. Some seepage flowed from the base of the downstream wall in the 220-foot length closest to the dam. The flow was clear and was probably due to rainfall runoff. A channel exists along the downstream toe of the dike along its most northerly reach. (Photograph 15) Water flowing in the channel results from interior drainage. The landside toe has its upper 12 inches composed of saturated soil.

Along the reach of the dike that has a concrete core, the physical condition is good. Some weathering has occurred on the top surface of the concrete; however, damage is insignificant. (Photograph 16) Along some reaches, the upstream slopes have sloughed away from the concrete core. Animal holes were noted in the downstream slope to the face of the concrete.

A heavy growth of vegetation exists along all portions of the dike where the earth can support such growth. (Photographs 17 and 18) The concrete has been breached to facilitate access to the reservoir by trailered boats. In this area, the gap is approximately 12 feet wide. The bottom is above spillway elevation, but within the dike freeboard and surcharge storage area. Limited flooding may occur behind the dike with substantial surcharge storage.

(2) Spillway. The condition of the spillway is considered fair to poor. The concrete along the wing walls is cracking and spalling. Some of the granite cap stone along the top of the spillway have dislodged and moved 2 to 3 feet downstream. Based on the flow of water over the spillway, it appears that the center is somewhat higher than either end. The approach channel is in good condition; however, the downstream channel is cluttered by heavy vegetation ranging from brush to 3 to 4 inch diameter trees. Erosion is also occurring along the downstream river banks. The water passing over the spillway returning to the Stillwater River is hampered by an arched highway culvert (12 feet wide x 4 feet high opening) under West Greenville Road which results in the flooding of a field between the culvert and the spillway. (Photograph 24)

d. Reservoir Area. The reservoir shores are quite highly developed with residences. During a Spillway Design Flood (SDF), only shallow inundation could be expected at the residences along the shores of the reservoir. These residences are shown on the quadrangle map (Figure 3, Appendix B).

e. Downstream Channel. The maximum channel capacity downstream of the reservoir has not been determined. The channel directly downstream of the outlet works and spillway is highly vegetated and narrow; and during high flows the bank would overflow, but with little resulting damage. The restrictive Route 44 highway embankment is located approximately 1,500 feet downstream of the outlet works. The first flood-prone developments are located approximately 6,000 feet further downstream of Route 44. These features are shown in Photographs 25 thru 29 and on Figure 3.

3.2 Evaluation

The dam and its appurtenances appear to be in good to fair condition. Vegetation growth is excessive and has restricted carrying capacities of the downstream channels and culverts. Erosion areas and sloughing are minor and pose no problems. Where the concrete wall has been breached limited flooding would occur only during periods of substantial surcharge storage.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures

As discussed in Section 1, the small gate is opened in September. Water is allowed to drain through the culvert until March when it is then closed. The gate remains closed throughout the summer until the day after Labor day when the small gate is again opened. During the summer months when the gate is closed, all excess flows are discharged over the spillway. The large 4 x 6 foot gate is never operated.

4.2 Maintenance of Dam

Maintenance of the dam and dikes is limited to that necessary to accommodate repairs required as a result of visual inspections.

4.3 Maintenance of Operating Facilities

The gate mechanisms are greased frequently.

4.4 Description of Warning Systems

Visits are made to the dam on a weekly basis and more frequently during severe storms. Based on observations, the owner's representative (See Paragraph 1.2 f.) notifies the local police department should he determine that the potential of danger to downstream residents exists due to the condition of the dam.

4.5 Evaluation

Operating procedures and warning systems are adequate for the dam except for the fact that the large gate is not operated. The inspections are not believed adequate as concrete and masonry structures are not inspected and the gate mechanism for the large gate is not operated to insure it would perform satisfactorily if it must be opened to release excess flows. Maximum capacities through the 1.3 foot outlet opening is only about 40 cfs. The 1.3 foot outlet opening is therefore deemed to be of ineffective regulation of the reservoir storage.

Total gate capacity of the 4 x 6 foot wooden gate, if operational, might be as high as 550 cfs. The 4 x 6 foot gate is therefore deemed to be of creditable size and should be maintained operational and in good repair at all times.

At present, there is no vegetation control either on the earth structures or in the channel and spillway areas.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data. There is no known design criteria or data available.

b. Experience Data. There is no past flood or operational history available for Waterman Reservoir Dam. The damtender stated that in the last 10 years the largest amount of water that he was aware of in the reservoir was in March 1968. At that time the reservoir rose about 1 foot above spillway crest which would indicate a corresponding discharge of about 600 cfs.

c. Overtopping Potential. Based on the "New England Regional Guide Curve", the Probable Maximum Flood (PMF) peak for Waterman Reservoir Dam is estimated to be about 11,200 cfs (1,400 csm).

Based on the size classification of the project (INTERMEDIATE), and the hazard potential classification (HIGH), the "Guidelines" recommend the full PMF as the Spillway Design Flood (SDF). It is estimated that a flow of this magnitude could result in a water surface elevation at the site of 336.1 feet MSL, or a depth of 2.1 feet over the non-overflow section. At the top of dam the spillway capacity is sufficient to discharge the estimated Standard Project Flood.

d. Dam Failure Analysis. A cursory analysis was made to assess the downstream impact of a sudden dam failure. With the reservoir at top of dam, the spillway capacity would be 4500 cfs or about 40 percent of the Probable Maximum Flood discharge. Assuming the dam failed at this level, producing a breach width of 80 feet, equal to 40 percent of the effective non-overflow section of the dam, and a breach depth of 12 feet, equal to the difference in elevation between top of dam and tailwater, the peak discharge through the breach would be approximately 5500 cfs. The flow plus spillway discharge would total about 10,000 cfs and could conceivably produce a downstream flood wave in the order of 12 feet. Such a failure would likely wash out two highway crossings located 1400 and 1500 feet downstream, respectively. An industrial Mill located about 500 feet downstream of these culverts could conceivably be undermined or receive some shallow flooding. The first significant impact area is located another 3000 feet downstream, consisting of 20 to 25 residential homes, that could be exposed to an estimated 3 to 5 foot flood wave. Approximately 7,000 feet beyond these residences, the discharges would enter Stillwater Reservoir where they would be largely dissipated. Based on this assessment the hazard potential, in the event of dam failure, would be considered significant to high, according to present guidelines.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structures

a. Visual Observations. The stability of each of the various structures is good. The low earth dam and dikes have retained their slopes with little sloughing, except near the gate house. Although the granite stones on the overflow structure (spillway) have moved, they pose no structural hazard. The spillway is only three feet high and the ground is the same level inside and outside the reservoir.

b. Post Construction Changes. Except for the changes noted in this report and on inspection reports in the Appendices, no records of any post construction changes are available.

c. Seismic Stability. This dam is located on the border of Seismic Zones 1 and 2 and hence does not have to be evaluated for seismic stability according to the OCE Recommended Guidelines.

SECTION 7

ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Overall, the general condition of the Waterman Reservoir Dam is good to fair. The dam has functioned for more than 140 years with no danger to downstream residents and with some repairs to eroded and sloughed areas and necessary vegetation control, it should continue to function safely for the foreseeable future.

b. Adequacy of Information. The information available is such that the assessment of the condition of the dam must be based on the visual inspection.

c. Urgency. Since the dam is only 6 to 10 feet high with the maximum height near the gate structure of 19 feet, and since there is only moderate downstream damage potential, the need for additional investigation is not considered as high priority.

d. Need for Additional Investigation. The information available from the visual inspection indicates that there are some problems with sloughing of the embankment near the gate house, cavitation of the concrete conduit through the dam and poor vegetation control throughout the entire project area. Although these are not serious, studies do indicate the potential for overtopping of the dam by 2 feet during the occurrence of the PMF. Additional investigation is warranted since there are about 2 dozen single family houses and a school downstream of the dam.

7.2 Recommendations

In view of the potential for overtopping of the dam during the occurrence of the PMF, a qualified consultant should be engaged to conduct a more detailed hydraulic and hydrologic investigation for the entire drainage area.

7.3 Remedial Measures

a. Alternatives. None

b. Operation and Maintenance Procedures. The dam, dikes and spillway are not adequately maintained. It is recommended the owner accomplish the following items within the next 1 to 2 years:

(1) The 1.3 x 1.3 foot outlet opening in the gate is inadequate as a means of emptying the reservoir, if necessary; therefore, the larger 4 x 6 foot gate should be made operational and then kept in good repair to provide greater operational capability and a means of emptying the reservoir.

(2) The cavitations in the conduit should be repaired.

(3) Eroded and sloughed areas on the upstream face of the main dam should be repaired.

(4) Existing brush and tree growth on the dam, dikes and in the spillway channel should be removed.

(5) Displaced granite blocks on the spillway should be reset in their proper locations.

(6) Round the clock surveillance should be provided by the owner during periods of unusually heavy precipitation. The owner should develop a formal warning system with local officials for alerting downstream residents in case of emergency.

APPENDIX A

INSPECTION REPORT

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Waterman Reservoir Dam
Smithfield, R.I.

DATE 12/15/77 & 12/21/77

TIME 0930 to 1400

WEATHER Cloudy to Rain

W.S. ELEV. 330± U.S. 317± DN.S. (MSL)

PARTY:

1. Frank Notardonato — 6. Team Leader
2. Farrell Mc Millan — 7. Hydraulic Engr.
3. Roger N. Poisson — 8. Soils Engr
4. Peter Janaros — 9. Representative, State of R.I.
5. _____ — 10. _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Main Dam	1, 2, 3, 4	
2. Earth Dike	2, 3	
3. Concrete Core Dike (West of Spillway)	1, 4	
4. Spillway	1, 2, 3, 4	
5. Concrete Core Dike (East of Spillway)	3	
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam DATE 12/15/77

PROJECT FEATURE #1 Main Dam NAME Poisson

DISCIPLINE Hydraulic & Soils NAME McMillan

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	334 ± MSL
Current Pool Elevation	330 ± MSL
Maximum Impoundment to Date	Not Known
Surface Cracks	None Observed
Pavement Condition	No pavement
Movement or Settlement of Crest	None evidenced
Lateral Movement	" "
Vertical Alignment	Good
Horizontal Alignment	Follows general shoreline
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	Stairs near gatehouse have moved out and dropped 3.5' from Top steps.
Trespassing on Slopes	Yes, few paths where vegetation destroyed. both U.S and D.S.
Sloughing or Erosion of Slopes or Abutments	Yes, near gatehouse, U.S side. Also in areas of U.S slope along dam.
Rock Slope Protection - Riprap Failures	Yes, near gatehouse, U.S.
Unusual Movement or Cracking at or near Toes	none observed D.S. U.S under water.
Unusual Embankment or Downstream Seepage	none observed
Piping or Boils	none observed
Foundation Drainage Features	no information available
Toe Drains	" " "
	Water level Gage U.S.

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam DATE Dec. 21, 1977

PROJECT FEATURE Gate structure & #1 outlet works. NAME Farrell McMillan

DISCIPLINE → HYDROLOGY & SOILS NAME Roger Poisson

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	N/A
Bottom Conditions	UNABLE TO SEE BECAUSE RESERVOIR IS FULL
Rock Slides or Falls	N/A
Log Boom	NO LOG BOOM
Debris	NONE SEEN - INDICATION BY DAM TENDER THAT DEBRIS IS NO PROBLEM
Condition of Concrete Lining	UNDER WATER
Drains or Weep Holes	N/A
b. Intake Structure	
Condition of Concrete	WHAT COULD BE SEEN LOOKS GOOD.
Stop Logs and Slots	NONE
trash bars	YES - INDICATED THAT THEY ARE IN FAIR CONDITION. UNABLE TO SEE THEM AS THEY WERE UNDER WATER.

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam #1 DATE 12/21/77

PROJECT FEATURE Gate Structure & Outlet Wks NAME McMillan

DISCIPLINE Hydrology & Soils NAME Poisson

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None noted
Visible Reinforcing	do
Rusting or Staining of Concrete	do
Any Seepage or Efflorescence	do
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	none noted - although there are some small cracks
Cracks	
Rusting or Corrosion of Steel	none noted
b. Mechanical	2 gates - 1 - 4'x6' Large gate (wooden) - not operated in 15 years. 16"x16" opening cut into 4'x6' gate. 1 - 2'x3' small gate (wooden) directly upstream of 4'x6' gate. - good condition - this is gate operated by dam tender. Gates are gear & screw. Note: Even with the 2'x3' gate opened, their is only a 16" square opening because the 4'x6' gate is always closed and the 2'x3' is behind (upstream) of the 4'x6' gate.
Air Vents	N/A
Float Wells	N/A
Crane Hoist	N/A
Elevator	N/A
Hydraulic System	N/A
Service Gates	N/A
Emergency Gates	N/A
Lightning Protection System	none
Emergency Power System	none
Wiring and Lighting System	none

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Res. Dam DATE 12/21/77

PROJECT FEATURE Gate structure & Outlet Works NAME Farrell McMillan

DISCIPLINE HYDROLOGY & SOILS NAME Roger Poisson

AREA EVALUATED	CONDITION
OUTLET WORKS - [redacted] AND CONDUIT	
General Condition of Concrete	POOR
[redacted] Staining on Concrete	YES FROM WATER
Spalling	YES - ON A LINE RUNNING FROM TOP OF LARGE GATE TO NEAR BOTTOM OF CONDUIT AT END OF CONDUIT
Erosion or Cavitation	
Cracking	NONE SEEN
Alignment of Monoliths N/A	
Alignment of Joints N/A	
Numbering of Monoliths N/A	

Note: On 15 Dec 77 (initial inspection) the reservoir was spilling over the spillway and th 1.3 foot opening in the 4x6 foot gate was closed. the closure was to facilitate installation of a new sewer line along still River downstream of the dam. On 21 Dec 77 (2nd inspection) the 1.3' foot opening was completely open and the reservoir level was dropping.

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Res. Dam DATE 12/21/77

PROJECT FEATURE Gate structure & Outlet works NAME Farrell McMillan

DISCIPLINE HYDROLOGY & SOILS NAME Roger Poisson

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	VERY GOOD
Rust or Staining	NONE SEEN
Spalling	NONE SEEN
Erosion or Cavitation	NONE SEEN
Visible Reinforcing	NONE SEEN
Any Seepage	YES - SMALL TRICKLE AT BASE OF LEFT WINGWALL OF OUTLET STRUCTURE. (NOT SERIOUS)
Condition at Joints	
Drain holes N/A	
Channel	
Loose Rock or Trees Overhanging Channel	CHANNEL IS NARROWED DOWN TO ABOUT A 15' STREAM BECAUSE OF HEAVY BRUSH & SMALL TREES GROWING IN CHANNEL.
Condition of Discharge Channel	→ MUCH brush & SMALL TREES MAKING DISCHARGE CHANNEL A POOR TO FAIR CHANNEL FOR DISCHARGE.
WING WALLS - Constructed of 4.5' x 2.5' x 1.0 granit blocks placed w/o mortar.	Very Good Condition

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam DATE 12/15/77

PROJECT FEATURE Dike #2 NAME Poisson

DISCIPLINE Hydraulic & Soils NAME McMillan

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	334 ± MSL
Current Pool Elevation	330 ± MSL
Maximum Impoundment to Date	Information not available
Surface Cracks	none observed
Pavement Condition	No pavement
Movement or Settlement of Crest	none evidenced
Lateral Movement	do
Vertical Alignment	Good
Horizontal Alignment	dike follows general shoreline
Condition at Abutment and at Concrete Structures	N/A
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	few trails, vehicle ruts, some wood cutting
Sloughing or Erosion of Slopes or Abutments	none observed
Rock Slope Protection - Riprap Failures	Limited amount of riprap on u.s. slope - no movement observed.
Unusual Movement or Cracking at or near Toes	u.s. underwater; d.s. - muddy toe due to ground water and interior drainage
Unusual Embankment or Downstream Seepage	Trickle from one small area - water clear - suspect snow and ice melt and rain from previous night
Piping or Boils	none observed
Foundation Drainage Features	information not available
Toe Drains	do.
Instrumentation System	do.

PERICDIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam DATE 12/15/77

PROJECT FEATURE Concrete Core Dike - West of spillway (3) NAME Notardonato

DISCIPLINE _____ NAME Tanaros

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	334 ± MSL
Current Pool Elevation	330 ± MSL
Maximum Impoundment to Date	UnKnown
Surface Cracks	none
Pavement Condition	no pavement
Movement or Settlement of Crest	none observed
Lateral Movement	do
Vertical Alignment	Good
Horizontal Alignment	Follows shoreline
Condition ~~at Abutments and of~~ Concrete ~~Structures~~ Core	Good, except for approx. 12' long section that was breached near sta. 30 to provide boat access to reservoir.
Indications of Movement of Structural Items on Slopes	none observed
Trespassing on Slopes	none. 1 animal hole noted however stopped at core.
Sloughing or Erosion of Slopes or Abutments	none. - However, earth embank. removed from core for distance of 200-300 ft near sta. 30.
Rock Slope Protection - Riprap Failures	No riprap.
Unusual Movement or Cracking at or near Toes	none observed
Unusual Embankment or Downstream Seepage	downstream tailwater - Results from surface brook carrying interior drainage from fields.
Piping or Boils	none observed
Foundation Drainage Features	no information available
Toe Drains	do
[illegible]	none

PERIODIC INSPECTION CHECK LIST

PROJECT Waterman Reservoir Dam — DATE 12/15/77

PROJECT FEATURE Spillway (#4) — NAME F McMillan

DISCIPLINE Hydraulics & Soils — NAME R. Poisson

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	(Spillway 201' long with east end elev approx. 3" higher than w
a. Approach Channel	
General Condition	Good - with some debris
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	Yes - both ends
Floor of Approach Channel	Stone lined - 1" ¼" dia brush growing on and Ds of spillway hampering flow for 100'
b. ~~Weir and~~ Training Walls	Yes
General Condition of Concrete	Concrete Faced training wall (masonry) poor condition
Rust or Staining	none observed
Spalling	Yes along ends
Any Visible Reinforcing	no
Any Seepage or Efflorescence	none observed
Drain Holes	none observed
c. Discharge Channel	
General Condition	poor
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	Yes very dense - blocking 100 ft of 201 ft long spillway
Floor of Channel	natural ground
Other Obstructions	Highway bridge on Rte 116 arch type Culvert 12' wide 4' high
d. Weir (EL 330 ± msl)	- Granite block capped - good condition except some capstone has dislodged and tilted downstream.

APPENDIX B

PAST INSPECTION REPORTS,
DAM LAYOUT & DETAILS

COPY OF FULL REPORT AS CONTAINED IN YEARLY REPORTS

OF COMMISSIONERS OF DAMS AND RESERVOIRS

1893 - The superficial area of this reservoir is 318 acres averaging 9 feet depth of water with a fall of 12 feet. Rollway 100 feet long; sluiceway drawing from bottom of pond through a stone culvert opening 2'x3'. The reservoir is formed by several dams crossing ravines and aggregating about one mile in length. They are composed chiefly of good material of clayey gravel in sufficient quantity. The embankment at points of greatest depth is backed with a substantial stone wall and the front is well protected by riprap. There are several leaks from the dam, but none of them appear to carry material from the structure and they are mostly located where the pond is comparatively shallow. They require, however, careful watching and the Commissioner has called the attention of the Reservoir Company to them. The dam at the gatehouse is deemed to be somewhat insecure, and it was suggested that the back wall should be taken down in part and rebuilt; and that buttress walls should be so constructed as to strengthen that portion of the structure. These suggestions were promptly complied with and the work has been completed so that the whole structure appears to be in good condition. The dam was constructed in 1837 and now at the age of 45 years, it has no indication of danger.

1895 - This dam has not been filled to overflowing since the date of the commission relating to "Dams and Reservoirs." Are retaining structures therefore have not been observed while in active service under a full reservoir. In a former report at a time when the reservoir was perhaps two thirds full some portions of the dam was reported as in a somewhat leaky condition at that stage of the water. The material composing the dam is generally of good quality and of sufficient quantity to insure its stability. The leakage then must be the result of faulty construction or a faulty foundation and the extent of damage (if any exists) can only be computed by observations on the action of the structure under a full reservoir. The commissioner's report of 1883, together with the herein annexed diagrams in plates 10, 11 and 12, contains all that may be said in repation to this important reservoir without an opportunity for observing the action of the retaining structure under full service.

1901 - The proprietors of the Waterman Reservoir have removed stranded stumps and placed riprap on some 1000 feet of the embankment this year. The reservoir, situated at the headwaters of the Wonasquatucket River covers an area of 318 acres and is formed by several dams crossing ravines and aggregating about a mile in length. The dam constructed in 1837 and now shows no indications of danger. The several embankments at points of greatest depth are backed with substantial stone walls and their

fronts are protected by riprap. I would call your attention to plates 577, 578 and 579 as representing principal parts of the dam.

1919 - Last spring I was called upon by the Secretary of the State Board of Public Roads, who complained that the action of the waves on the slopes of the causeway crossing an arm of the Waterman Reservoir was causing damage and that the conditions were a menace to public safety. The causeway is a part of the public road system. Claiming that the causeway was a dam and consequently within my jurisdiction, he requested me to remedy the trouble. Waiving the question as to whether the causeway was a dam or not, I called the officials of the Woonasquatucket Reservoir Company who own the reservoir, only to find that the causeway had always been maintained by the town of Smithfield in pursuance of an agreement between it and the reservoir company and that the reservoir company were not responsible for the condition of this causeway. I presume the Board of Public Roads proceeds the town of Smithfield in its responsibility as I have heard nothing further since reporting the above fact.

1916 - The principal and most insistent complaint came from the village of Greenville and referred to the condition of the Waterman Reservoir. There was a great quantity of water running over the spillway at this reservoir and some 18 inches of snow and ice in the surrounding woods. With every hollow full of water and the reservoir covered with thick ice the residents of the village of Greenville notified me of the dangerous situation and requested me to remedy the supposed danger to the dam by ordering the waste gates partially opened. It was claimed that the caretaker on the premises was incompetent and refused to relieve the situation. Having examined the premises I interviewed the President of the Woonasquatucket Reservoir Company and pointed out to him that there could be no lack of water for summer storage purposes as long as there was surplus water running to waste and a great accumulation of snow on the watershed; that a sudden warm rain might cause a disaster and that the fears of the residents could easily be allayed. The matter was adjusted.

1913 - The Waterman Reservoir has been the subject of report in the annual reports of the commissioner in the years 1892, 1894, 1897 and 1916. In 1916 it was reported that the citizens of the village of Greenville and vicinity complained of the high level of the water maintained in the reservoir. See letter re: complaint.

1921 - New culvert ny town of Greenville.

1927 - Construction of new State bridge on West Greenville Road #217

1928 - Repairs in progress.

DIVISION OF HARBORS AND RIVERS
LETTER TO
C. ROBERT LYNCH, CHIEF OF
DIVISION FROM
JOHN P. FARNSWORTH IN ANS.
TO LETTER
MARCH 26, 1939

← 3/27/39

These two are apparently the same. The Mountaindale Pond #125
is controlled by the Conasquatucket Reservoir Co. of which
I am Treasurer. We also control

✓ #111 — Waterman Reservoir Built ?
#120 — Upper Sprague " ?
#115 — Slack Reservoir " ?
#108 — Stillwater Reservoir " 1909/10
#121 — Lower Sprague " ?

All of these dams have been kept in the best repair possible.
Mr. A. W. Anderson, Circuit Road, Edgewood, is our engineer (WI
2623) and George Birch in Greenville has charge of gates.

My own address is 107 Prospect Street. Tel. Plantations 3652

/s/ John P. Farnsworth

All other dams on the river under control of individual mills.
Will be glad to cooperate in any way.

JPF

From [illegible] Cotton Dam #125

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS AND RIVERS

SPECIAL INSPECTION REPORT

DAM NO. 111

INSPECTED BY J. V. KEILY

TOWN - GLOCESTER-SMITHFIELD

111 NAME WATERMAN'S RESERVOIR ON BROOK / RIVER / TRENCH STILLWATER WATERSHED WOONASQUAT...

WOONASQUATUCKET WATER COMPANY

C/O MR. HOLDSWORTH, PREST. C/O PROVIDENCE D. B. & C. CO., 52 VALLEY ST. PROVIDENCE, R. I. TEL WE ...

NEW CONSTRUCTION REPAIRS INSPECTION ONLY

APPROVED CONTRACTOR

INSPECTION REPORT BY JOHN V. KEILY REASON ROUTINE DATE 11/1/46

EMERGENCY:

1. A. R. ANDERSON, ENGINEER, RES. 90 AUSDALE RD. CRANSTON. TEL. WI 2623
OFFICE FIDELITY & CASUALTY CO. 511 IND. TRUST. TEL GA ...

2. HENRY A. FULLER, GREENVILLE (SNAKE HILL RD, GLOCESTER) TEL. SCIT. 4316

3. NAPOLEON GILBERT, PUTNAM AVE., GREENVILLE, TEL. CE 0115-J (CARETAKER)

EARTH DIKE AT GATE HOUSE IN GOOD CONDITION; WALLS DOWN-STREAM OK. RIPRAP ON POND SIDE IN FAIR SHAPE; GROUTED ABOVE AND BELOW MEAN WATER LINE. POND ABOUT TWO FEET BELOW NORMAL TO-DAY GATE PARTLY OPEN. BRUSH RECENTLY CUT ON EMBANKMENT AND BURNED OVER. GOOD GRASS COVER ON TOP OF EMBANKMENT (6'-10' WIDE) NO EROSION HERE. BALANCE OF EMBANKMENT IN GOOD CONDITION. CONCRETE ... OK. BRUSH CUT AND BURNED AT SPILLWAY; CLEAN AND OK. NEEDS A LITTLE FILL BEHIND CAPSTONES (ABOUT 1 CY PLUS) WHEELBARROW JOB WHEN WATER IS LOW. SO REPORTED TO ANDERSON. *DAM IS UNDER CONSTANT SUPERVISION OF CARETAKER AND REGULATION OF GATES IS DONE BY HIM.

11/26/47 WATER VERY LOW TODAY. SMALL BRUSH ON EMBANKMENT AND SPILLWAY WILL NEED CUTTING SOON.

CONDITION
GATES
...BER
...TION
...S & WHEELS
...MENT
CONDITION
...ACHES
...OSION
...ES & TREES
...RAP
...
CONTROLS
CONTACTED
...
...IONS LEFT
EMERGENCY CALL

DIVISION OF HARBORS AND RIVERS
SURVEY OF STATE DAMS.

Woonasquatucket Drainage Area ~~#5~~ Waterman Reservoir #111

Drainage area at the dam 8.19 sq. mi.

No spillway as such. Notch in the embankment with the ground at the same level inside and outside the pond, 201 feet long and 3 feet deep, serves to let the water escape when the pond overfills. The capacity of this notch can not be estimated without a series of current measurements at the time of high water. It is probably as much or more than 4800 cfs.

Draw off gate 2' x 3' with a discharging capacity of about 60 cfs.

Greatest expected freshet 1007 cfs.

Area of reservoir by U. S. 10th Census 318 acres.
" " " " New state map, 276 acres.
Depth at the gate 15.8 feet.

On the basis of the U. S. Census area the pond will hold 840 cfs. for 36 hours. Or on the basis of the state map area it will hold 730 cfs. for 36 hours. On either basis the pond will seldom overflow unless a storm of great volume comes on, with the reservoir partly full.

This dam appears to be in excellent condition.

July 15, 1940.

DIVISION OF HARBORS AND RIVERS

SURVEY OF DAMS IN RHODE ISLAND

Woonasquatucket River Basin — #111 Waterman Res.

Drainage Area at the Dam — 9.1 Sq. Mi.

February 1948
Spillway - 201' x 3' deep, capacity - — 4422 c.f.s. *

Estimated extreme freshet — 673 c.f.s.

*Draw-off culvert capacity 2' x 3' wide, under 18 ft. head can be added to this discharge capacity.

Memo

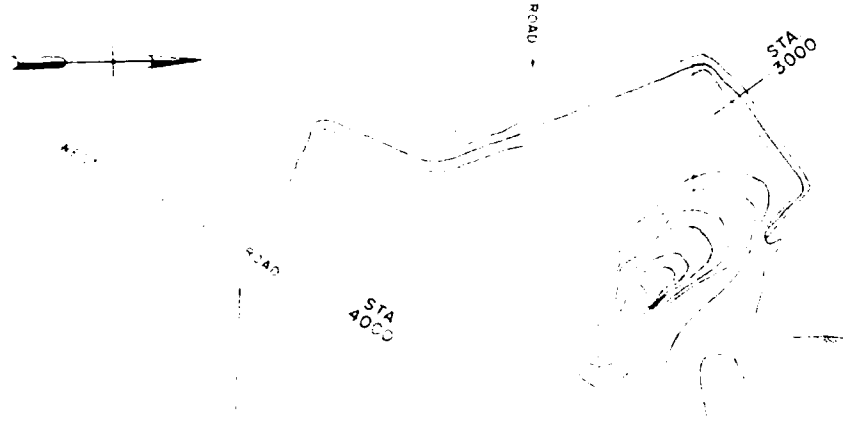
Jul. 11, 1958

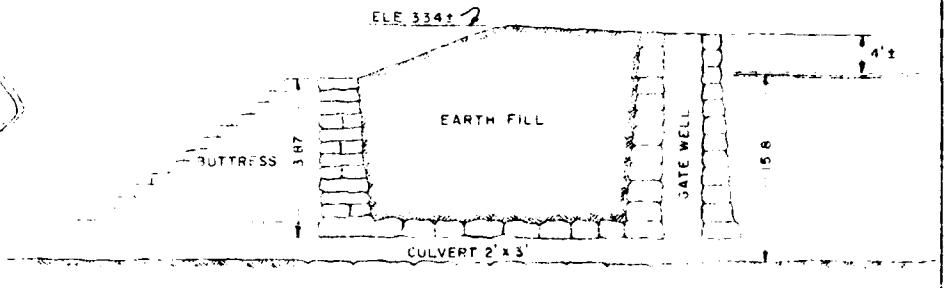
Re: Waterman Reservoir.

Mr. Anderson of Woonasquatucket River Association telephoned me this afternoon to tell me that the gate at Waterman Res. had let go and they were losing a lot of water. He wanted permission to make a temporary closure until permanent gate repairs could be made later on.

I told him to go ahead and make the temporary repairs.

H. Lee

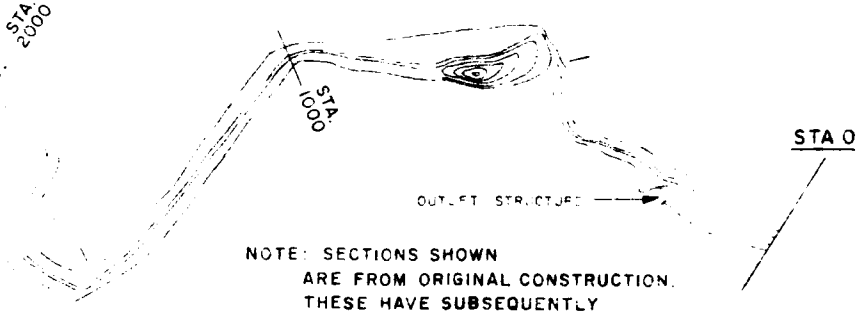




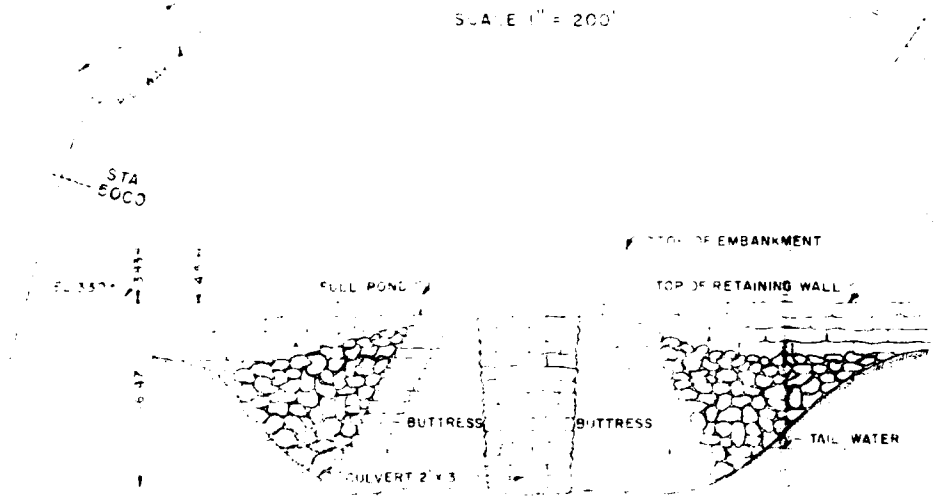
CROSS SECTION AT DRAW OFF GATE
SCALE 1" = 10'

POND

SCALE 1" = 200'



RESERVOIR



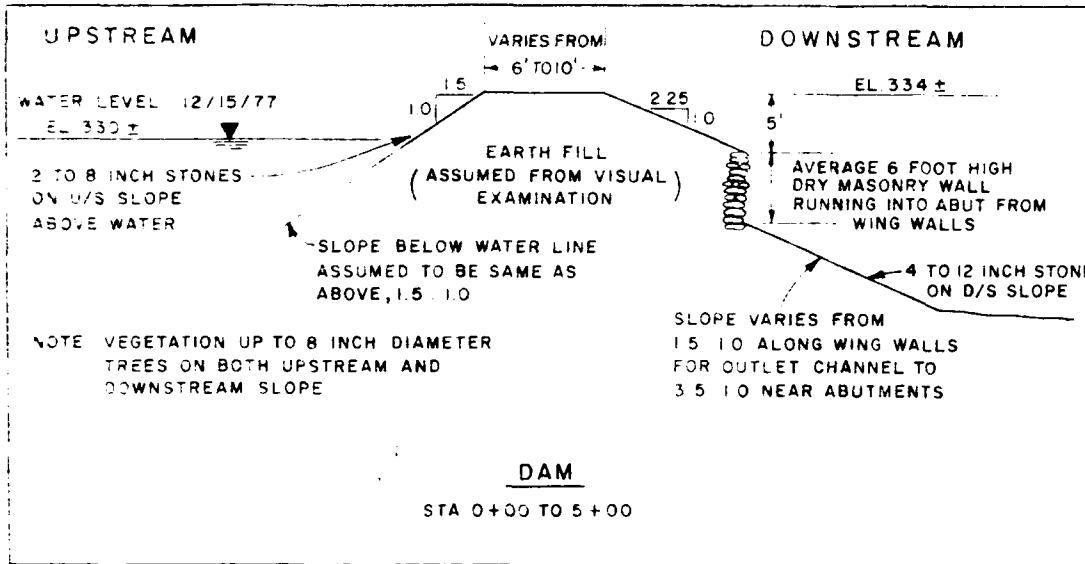
DOWN STREAM ELEVATION AT DRAW OFF GATE
SCALE 1" = 10'

NOTE: SECTIONS SHOWN ARE FROM ORIGINAL CONSTRUCTION. THESE HAVE SUBSEQUENTLY BEEN MODIFIED; HOWEVER AS BUILT DETAILS ARE NOT AVAILABLE.

WATERMAN RESERVOIR DAM

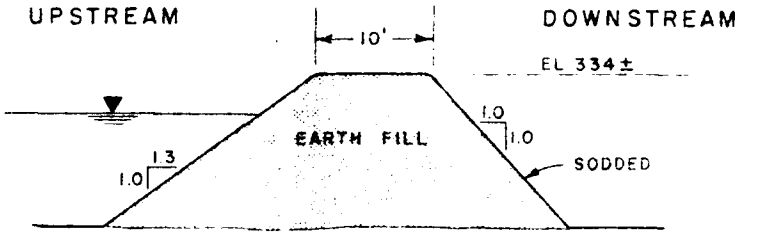
GENERAL PLAN

FIGURE 1



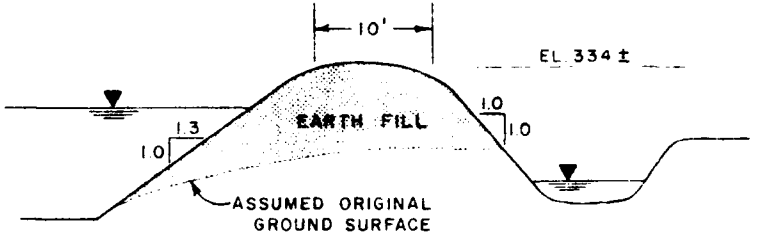
DAM

STA 0+00 TO 5+00



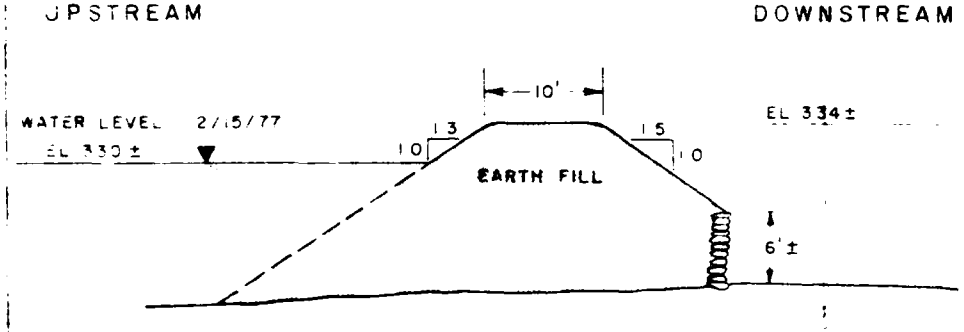
DIKE

STA 10+00 TO STA 15+50



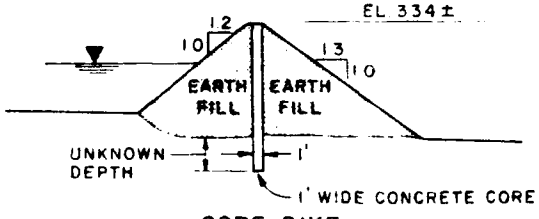
DIKE

STA 15+50 TO STA 23+70



DIKE

STA 7+ 0 TO 10+00



CORE DIKE

STA 27+30 TO STA 55+00

WATERMAN RESERVOIR DAM

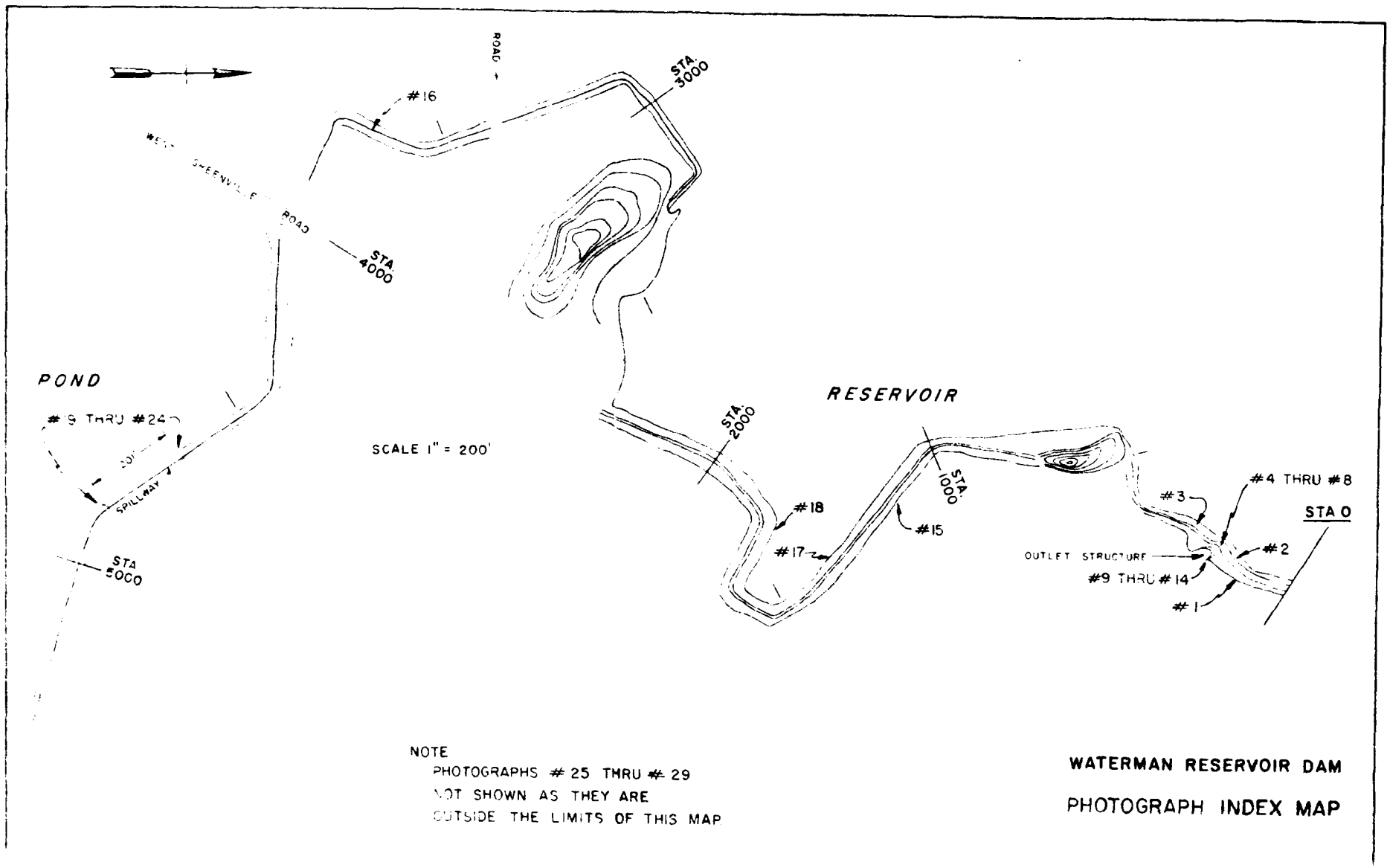
TYPICAL SECTIONS

SCALE 1" = 10'

FIGURE 2

APPENDIX C

PHOTOGRAPHS



NOTE
PHOTOGRAPHS # 25 THRU # 29
NOT SHOWN AS THEY ARE
OUTSIDE THE LIMITS OF THIS MAP

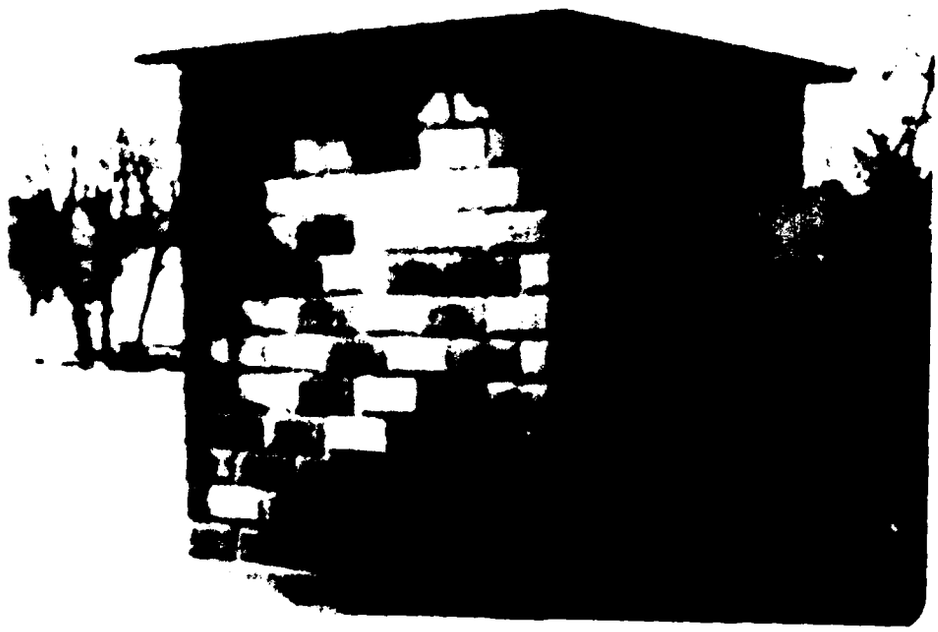
WATERMAN RESERVOIR DAM

PHOTOGRAPH INDEX MAP

Photograph 1 Main Dam - Looking north at downstream slope near the north wing wall.

Photograph 2 Main Dam - Looking south at upstream slope of south side.

Photograph 3 Main Dam - Looking north from the gate house at the upstream slope.



Photograph 4 Main Dam - Looking north at gate house.

Photograph 5 Main Dam - Sloughing of upstream slope at south side of gate house.

Photograph 6 Main Dam - Looking north at slump near the north side of the gate house.

Photograph 7 Main Dam - Sloughing at north side of gate house

Photograph 8 Main Dam - Inlet wing wall and fallen stairs.

Photograph 9 Main Dam - Outlet conduit from the north wing wall. Note: Wooden stop log structure in conduit.

Photograph 10 Main Dam - Seeping yellowish substance from right wing wall in outlet channel.

Photograph 11 — Main Dam - Seeping yellowish clouding water near right wing wall.

Photograph 12 — Main Dam - Large gate containing smaller gate in it. Note leakage.

Photograph 13 Main Dam - Erosion and cavitation along outlet conduit left wall.

Photograph 14 Main Dam - Erosion and cavitation along outlet conduit right wall.

Photograph 15 Earth Dike - Downstream toe near southern end of dike. Stream used for draining field.

Photograph 16 Earth Dike - East along concrete core of Dike. Note vegetation, covered slopes and spalling concrete.

Photograph 17 Earth Dike - Dike shown at left and across reservoir.

Photograph 18 Earth Dike - West toward upstream slope just after first bend in dike.

Photograph 19 Spillway - View from west wing wall. Note fallen granite blocks.

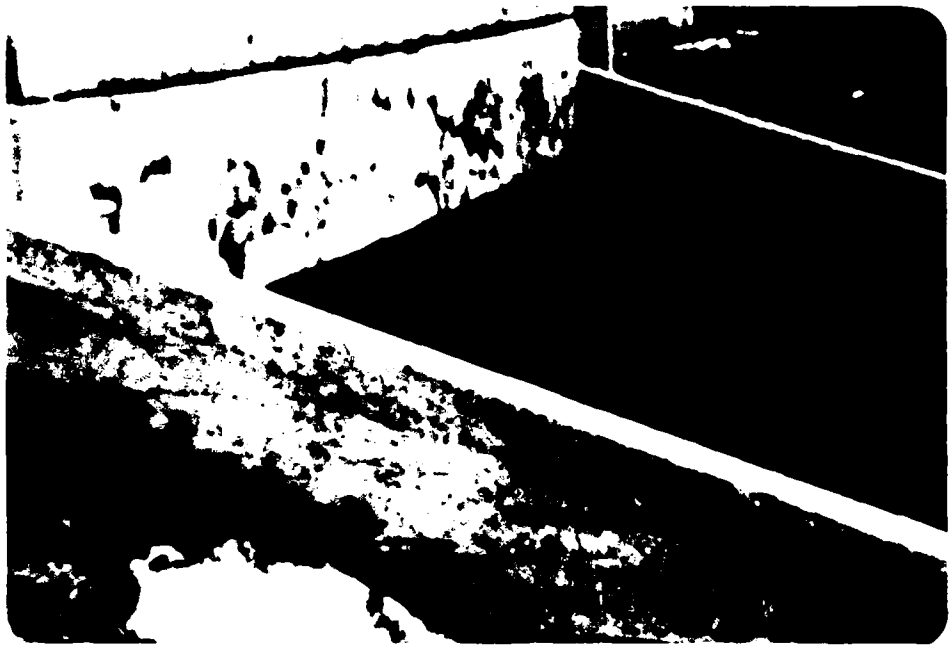
Photograph 20 Spillway: View from west bank of downstream spillway channel.

Photograph 21 Spillway - Center section of spillway. Note vegetation.

Photograph 22 Spillway: Westerly view from east wing wall.

Photograph 23 Spillway: Southerly view of east wing wall.

Photograph 24 Highway culvert downstream of spillway. Limits outflow from channel.

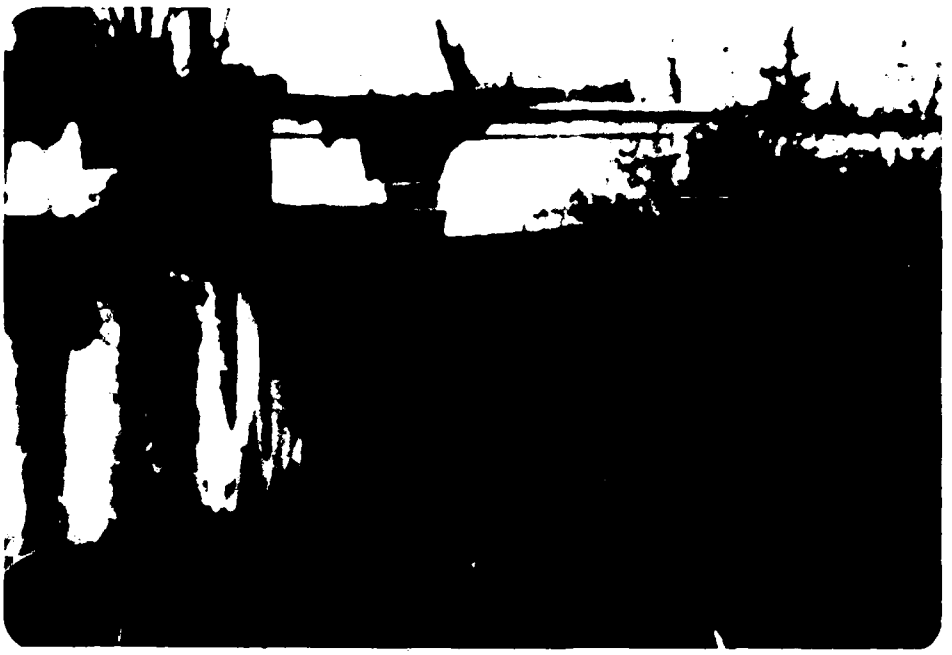


Photograph 25 View of east side of 2-lane state highway bridge crossing reservoir.

Photograph 26 Looking south at wing wall of 2-lane state bridge crossing reservoir.

Photograph 27 Upstream face of West Greenville Road bridge over outlet channel.

Photograph 28 Downstream face of West Greenville Road bridge over outlet channel.



Photograph 29 Rte. 44 Bridge over outlet channel.

APPENDIX D

HYDROLOGIC COMPUTATIONS

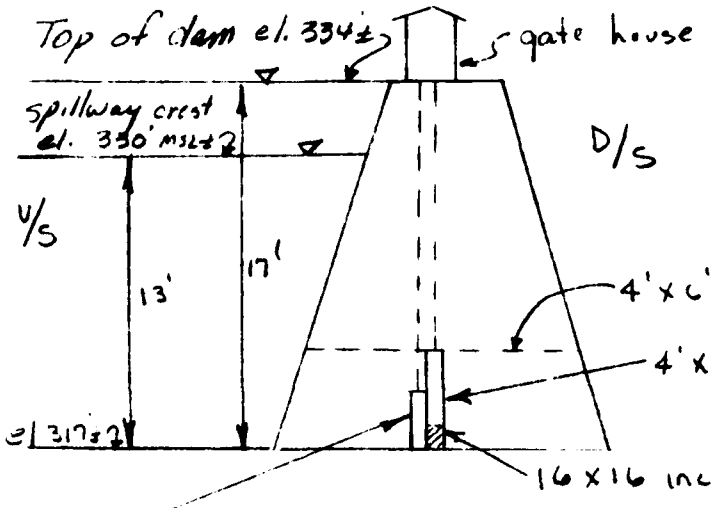
NEW ENGLAND DIVISION

CORPS OF ENGINEERS, U S ARMY PAGE

SUBJECT Waterman Reservoir Dam - Smithfield, R.I.

COMPUTATION "Q" for gates

COMPUTED BY Hdmc CHECKED BY DATE Jan 9, 1978



"NOT TO SCALE"

area of 16x16 inch opening
$(16/12)^2 = 1.78\ ft^2$

area of 4'x6' culvert
$\Rightarrow 4' \times 6' = 24\ ft^2$

16x16 inch opening cut into 4x6 foot wooden gate

2x3 foot wooden gate that mounted on the back of the U/s side of 4x6 foot gate.

orfice formula:

$$Q = .7\sqrt{2g}\sqrt{\Delta H}\,A$$

for 16-inch square opening:

H = 13' @ spillway crest $Q = (.7)(8.02)(\sqrt{13})(1.78) = 36$ cfs

H = 17' @ top of dam $Q = (.7)(8.02)(\sqrt{17})(1.78) = 41$ cfs

for 4'x6' culvert

H = 13' @ spillway crest $Q = (.7)(8.02)\sqrt{13}(24) = 486$ cfs

H = 17' @ top of dam $Q = (.7)(8.02)\sqrt{17}(24) = 556$ cfs

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT Waterman Reservoir Dam - Smithfield, R.I. PAGE

COMPUTATION

COMPUTED BY Hmc CHECKED BY DATE Jan 18, 1978

from Quad sheet:

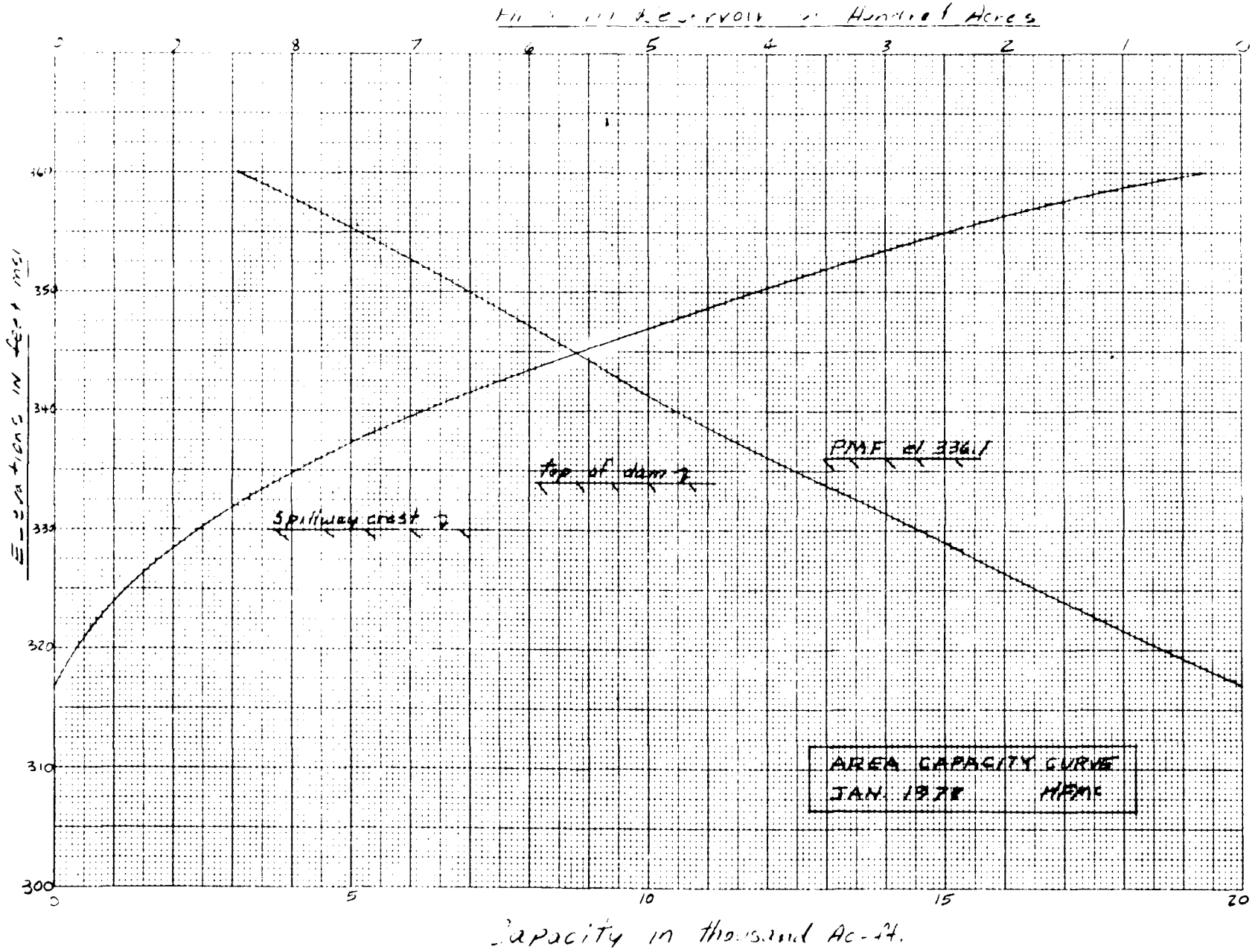
elev. (ft. MSL)	SQ. IN.	SQ. MILES	ACRES
330	2.95	.42	270
340	5.20	.74	478
350	7.10	1.02	653
360	9.20	1.32	845

from state inspection reports, Waterman Reservoir dam is an average of 9 feet deep, therefore:

(9 feet)(270 acres) = 2430* acre-feet.

Elev. (Ft. MSL)	Area (ac.)	Avg. Area (ac.)	Δ depth (ft.)	Δ Vol. Ac-ft	total vol. (ac.-ft.)
330	270				2430*
		374	10	3740	
340	478				6170
		566	10	5660	
350	653				11830
		749	10	7490	
360	845				19320

* Avg. area


Hundred Acres
360
350
340
330
320
310
300
PMF el 336.1
top of dam
Spillway crest
AREA CAPACITY CURVE
JAN. 1978 HPMC
Capacity in thousand Ac-ft.

NEW ENGLAND DIVISION

CORPS OF ENGINEERS, U.S. ARMY

SUBJECT [illegible] Pond Reservoir Levels - [illegible], R.I.

COMPUTATION Routing Curves

COMPUTED BY H.J.M. CHECKED BY DATE Dec. 29, 19[illegible]

Lower Reel = 12 feet below crest elevation of spillway

Spillway opening = 9.5 x 8' = 76' Spillway crest el = 330' MSL

Estimated elev. of Route 44 bridge = 325' MSL "L" of bridge

Lower Reel	ΔH	$.7129\sqrt{2gH}\,A$ (427 Factor) Qout.	Hz	$2.8 \times 4^{1.5}$ Qweir	Q TOTAL	
-13	0	0	0	0	0	
-12	1	427	0	0	427	-0
-11	2	604	0	0	604	
-10	3	740	0	0	740	
-9	4	854	0	0	854	
-8	5	955	0	0	955	
-7	6	1046	0	0	1046	
-6	7	1130	0	0	1130	
-5	8	1208	0	0	1208	
-4	9	1281	1	1400	2681	-4
-3	10	1350	2	3960	5310	-3
-2	11	1416	3	7275	8691	-2
-1	12	1479	4	11200	12679	-1
0	13	1540	5	15653	17193	0
+1	14	1598	6	20576	22174	+1
+2	15	1654	7	25928	27582	+2
+3	16	1708	8	31678	33386	+3
+4	17	1761	9	37800	39561	+4
+5	18	1812	10	44272	46084	+5
+6	19	1861	11	51076	52937	+6
+7	20	1910	12	58177	60107	+7
+8	21	1957	13	65621	67578	+8
+9	22	2003	14	73337	75340	+9
+10	23	2048	15	81333	83381	+10
+11	24	2092	16	89600	91692	+11
+12	25	2135	17	98130	100265	+12
+13	26	2177	18	106914	109091	+13
+14	27	2219	19	115947	118166	+14

NEW ENGLAND DIVISION

CORPS OF ENGINEERS, U.S. ARMY

SUBJECT Waterman Reservoir Dam — Emergency Spillway Rating Curve

COMPUTATION Rating Curve

COMPUTED BY Hand CHECKED BY DATE Jan 3, 1978

middle pond (spillway) length = 201' C = 2.8 (ASSUMED)

spillway crest = 330' MSL CULVERT: opening = 16'x6' = 96 ft²

$Q = A \cdot .7\sqrt{2g}\sqrt{\Delta H}$

SOLVE FOR ΔH

middle pool	"H"	Q_{SPILL} $(201)(2.8)H^{1.5}$	ΔH	UPPER POOL ELEV.	
spillway crest 330 → 0	0	0	0	0	
+1	1	563	1	332	+2
+2	2	1592	1.7	333.7	+3.7
+3	3	2926	2.3	335.3	+5.3
+4	4	4504	2.9	336.9	+6.9
+5	5	6295	3.4	338.4	+8.4
+6	6	8274	3.9	339.9	+9.9
+7	7	10427	4.4	341.4	+11.4
+8	8	12739	4.9	342.9	+12.9
+9	9	15201	5.3	344.3	+14.3
+10	10	17804	5.7	345.7	
+11	11	20540	6.2	347.2	
+12	12	23404	6.6	348.6	
+13	13	26389	7.0	350.0	
+14	14	29492	7.4	351.4	
+15	15	32707	7.8	352.8	
+16	16	36032	8.2	354.2	
+17	17	39462	8.6	355.6	
+18	18	42995	8.9	356.9	
+19	19	46627	9.3	358.3	
+20	20	50356	9.7	359.7	
+21	21	54180	10.0	361.0	
+22	22	58096	10.4	362.4	
+23	23	62101	10.7	363.7	
+24	24	66195	11.1	365.1	
+25	25	70375	11.5	366.5	
+26	26	74640	11.8	367.8	
+27	27	78987	12.1	369.1	
+28	28	83415	12.4	370.4	
+29	29	87924	12.8	371.8	
+30	30	92510	13.1	373.1	

NEW ENGLAND DIVISION

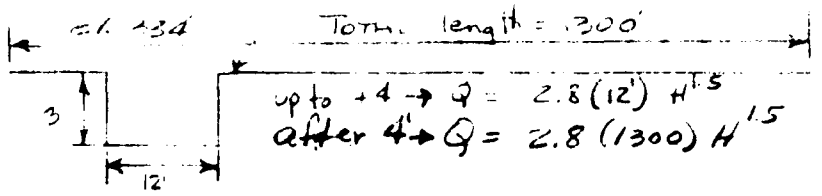
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT [illegible]

COMPUTATION [illegible]

COMPUTED BY [illegible] CHECKED BY DATE Jan 2 19[illegible]

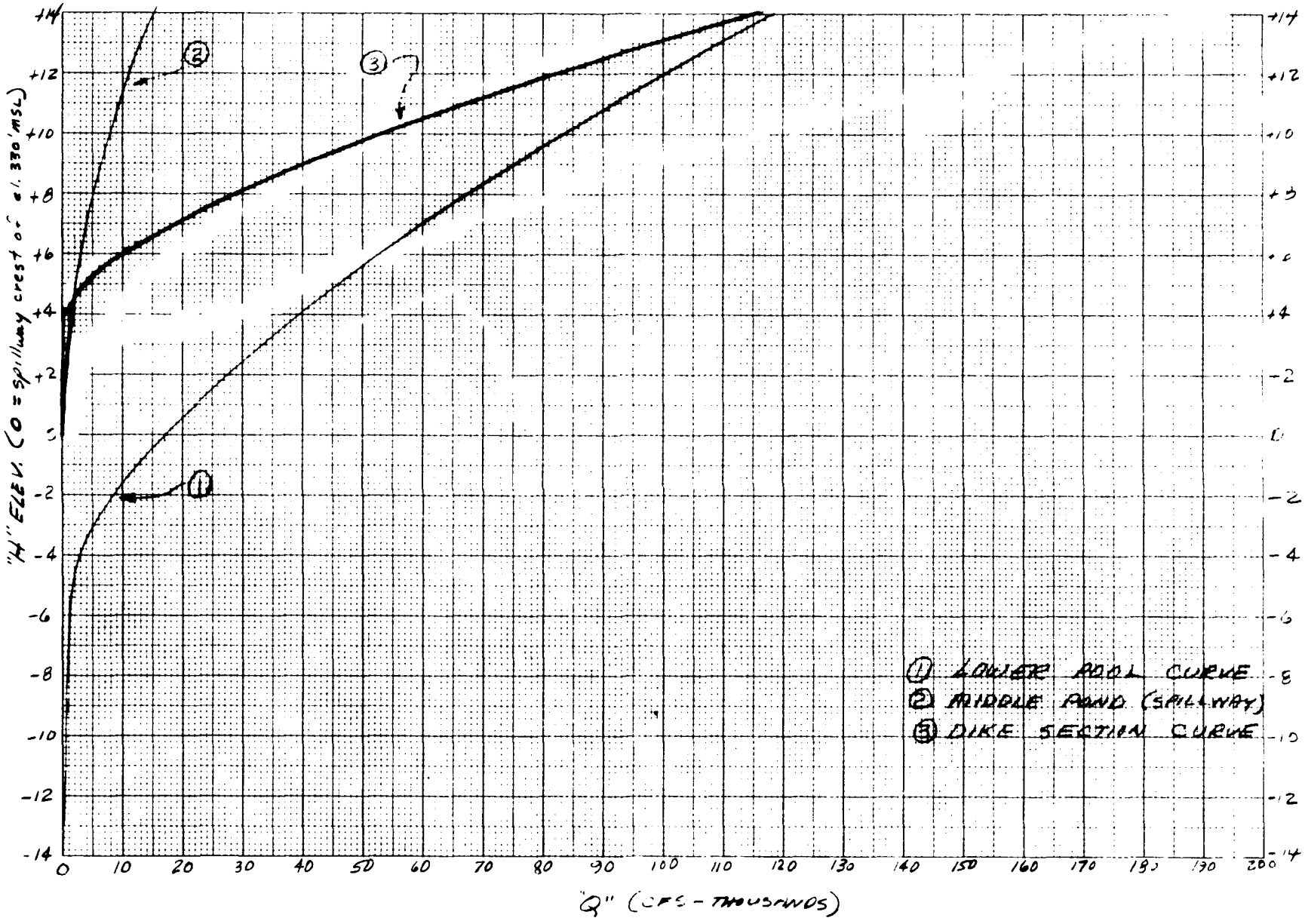
Dike sections



up to +4 → $Q = 2.8(12')H^{1.5}$

after 4' → $Q = 2.8(1300)H^{1.5}$

	"H"	ΔH	"Q"
Spillway crest → 330' MSL	0	0	0
	+1	1	34
	+2	2	96
	+3	3	177
Freeboard →	+4	4	269
	+5	1	3640
	+6	2	10295
	+7	3	18914
	+8	4	29120
	+9	5	40696
	+10	6	53497
	+11	7	67414
	+12	8	82364
	+13	9	98280
	+14	10	115107


"H" ELEV. (0 = spillway crest or ± 330' MSL)
+14
+12
+10
+8
+6
+4
+2
0
-2
-4
-6
-8
-10
-12
-14
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
"Q" (CFS - THOUSANDS)
(1) LOWER POOL CURVE
(2) MIDDLE POND (SPILLWAY)
(3) DIKE SECTION CURVE

NEW ENGLAND DIVISION

CORPS OF ENGINEERS, U S ARMY

PAGE

SUBJECT Waterbury Reservoir Dam - Waterbury, Vt.

COMPUTATION Part. Data

COMPUTED BY HMC CHECKED BY DATE Jan 6, 1978

Drainage area: 8.0 Sq. miles

Surface area: (at spillway crest) 267 acres, or .42 SQ. MILES Say 270 acres

Average 9 ft. depth. Therefore storage =

(9 ft.)(270 acres) = 2430 Ac.-Ft

From "Recommended Guidelines for Safety Inspection of Dams", Table 1 SIZE CLASSIFICATION:

Intermediate - because of the storage of 2430 AC. FT.

From same guidelines as above: table 2

HAZARD POTENTIAL CLASSIFICATION: = HIGH

HYDROLOGIC EVALUATION GUIDELINES:

Hazard	Size	Spillway Design Flood
HIGH	INTERMEDIATE	PMF

∴ SDF = MPF

SUBJECT [illegible], E.I.

COMPUTATION Peak Data

COMPUTED BY MMC CHECKED BY _____ DATE Jan 6, [illegible]

Spillway Design Flood:

D.A. = 8.0 sq. miles

Size Dam = Significant

Hazard Potential = HIGH

∴ SDF = MPF

① PMF from "USGS Paper #1887, Region 1"

PMF = 15800 CFS

② PMF from "New England Regional Guide Curve:"

Inflow = Outflow

PMF in CFS/sq mile = 1400

∴ (8.0 sq miles)(1400 CFS/sq mile) = 11,200 CFS

Using the "New England Regional Guide Curve" as my reference:

SDF = PMF = 11,200 CFS peak inflow

COMPUTATION Peak data

COMPUTED BY Hime CHECKED BY DATE June 6, 1978

CHECK TO SEE IF ASSUMPTION TO USE

INFLOW = OUTFLOW IS VALID

Reservoir Surface Area ("A" in acres) (at spillway crest) = 270 acres

Surcharge ("H" in Feet) (from Rating Curve) = 2.1 feet

(A)(H) = "S" "S" = Surcharge storage in Ac-Ft

(270 acres)(2.1) = 567.0 AC-Ft.

"S" ÷ Drainage Area (IN SQ. MILES) ÷ 53.333 AC-FT/SQ. MILE

equals "I" (inches of runoff)

i.e.

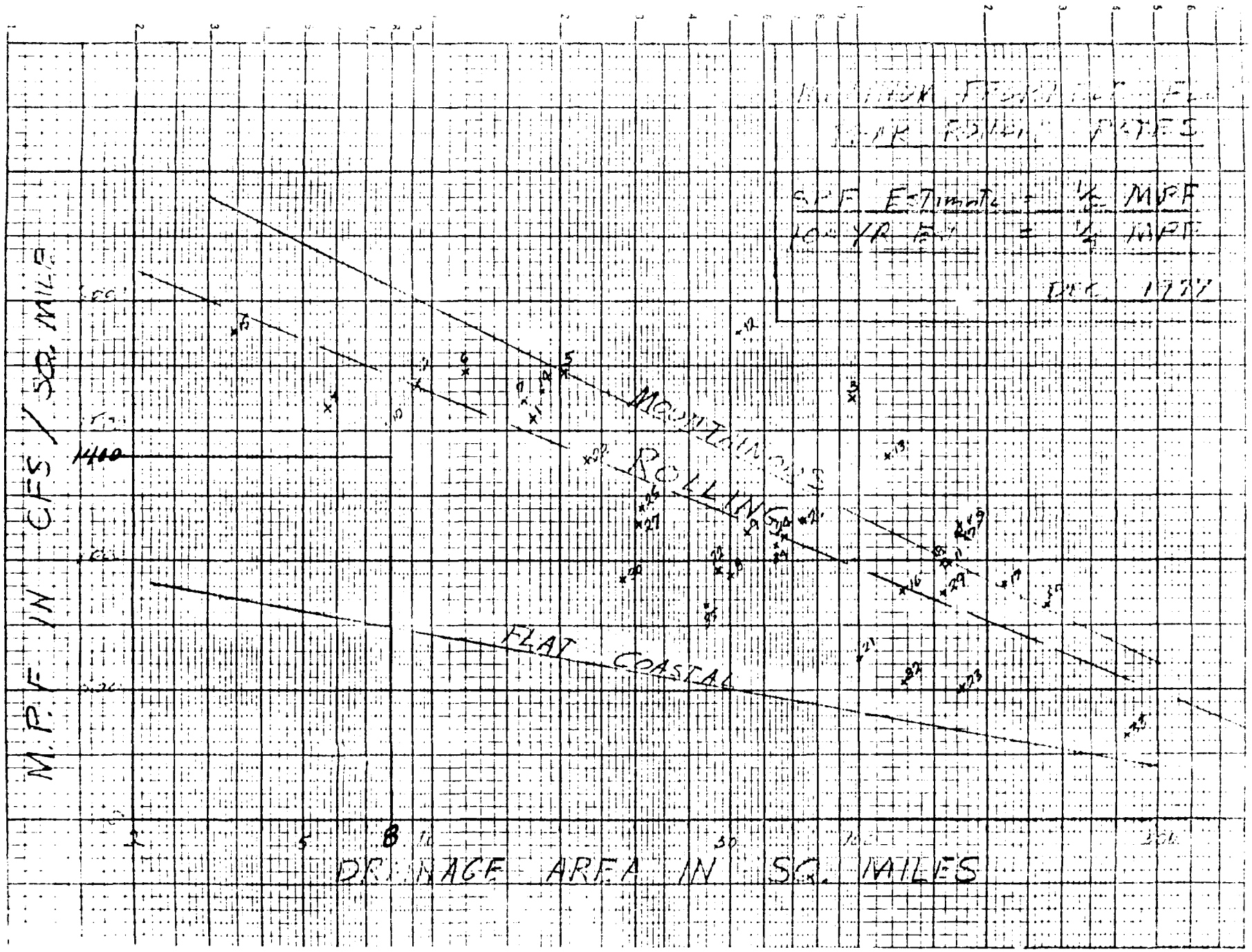
$$S / (D.A.)(53.333) \quad \frac{567 \text{ AC-FT}}{(8 \text{ SQ. MILES})(53.333 \text{ AC-FT/SQ. MILE})} = 1.33"$$

$$\left(1 - \frac{1.33"}{18"}\right) \text{Peak Inflow (11,200 CFS)} = \text{Outflow}$$

$$(1 - .07)(11{,}200 \text{ CFS}) = \text{Outflow}$$

$$.93(11{,}200 \text{ CFS}) = 10{,}400 \text{ CFS}$$

Guide Curve


M.P.F. IN CFS / SQ. MILE
MOUNTAIN
ROLLING
FLAT COASTAL
DRAINAGE AREA IN SQ. MILES

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COONTY	(6) CONGR DIST.	(8) STATE	(7) COUNTY	(8) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
RI	3103	NED	RI	007	01				WATERMAN RESERVOIR DAM	4152.7	7134.6	27JUL78

(13) POPULAR NAME	(14) NAME OF IMPOUNOMENT
	WATERMAN RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06	STILLWATER RIVER	SMITHFIELD	0	16500

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(27) NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
RECTPG	1837	SR	19	19	3750	2430	NED	N	N	N	N	27JUL78

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	4630	U	201	4500												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
WOONASQUATUCKET RES CO		

(49) REGULATORY AGENCY DESIGN	CONSTRUCTION	(50) OPERATION	MAINTENANCE
NONE			

(52) INSPECTION BY	(54) INSPECTION DATE DAY | MO | YR	(55) AUTHORITY FOR INSPECTION
NED	15DEC77	PL 92-367

(56) REMARKS

END

FILMED

8-85

DTIC